Tevatron Collider II Halo Removal System

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- Motives for the Collider Run II Collimator Halo Removal System upgrade.
- Halo Removal System Overview.
- Run II experience of halo removal and attempts to manage halo background losses at the IP's – CDF and D0.

Collimator System Upgrades for Run-II

- **Wanted to move to commercial hardware to replace in house motion controls.**
  - Collimators are faster and more reliable.
  - Each Collimator would be able to do feedback processing.
- **Wanted to move to a more automated system to reduce shot setup time and integrate controls with the Collider Sequencer.**
  - Goal was to shot setup Halo Removal times of about 5 min.
- **Wanted to move to a 2 stage collimator halo removal system.**
  - Build 4 new targets and 8 new secondary collimators .

Collimator System Upgrade Designs for Collider II

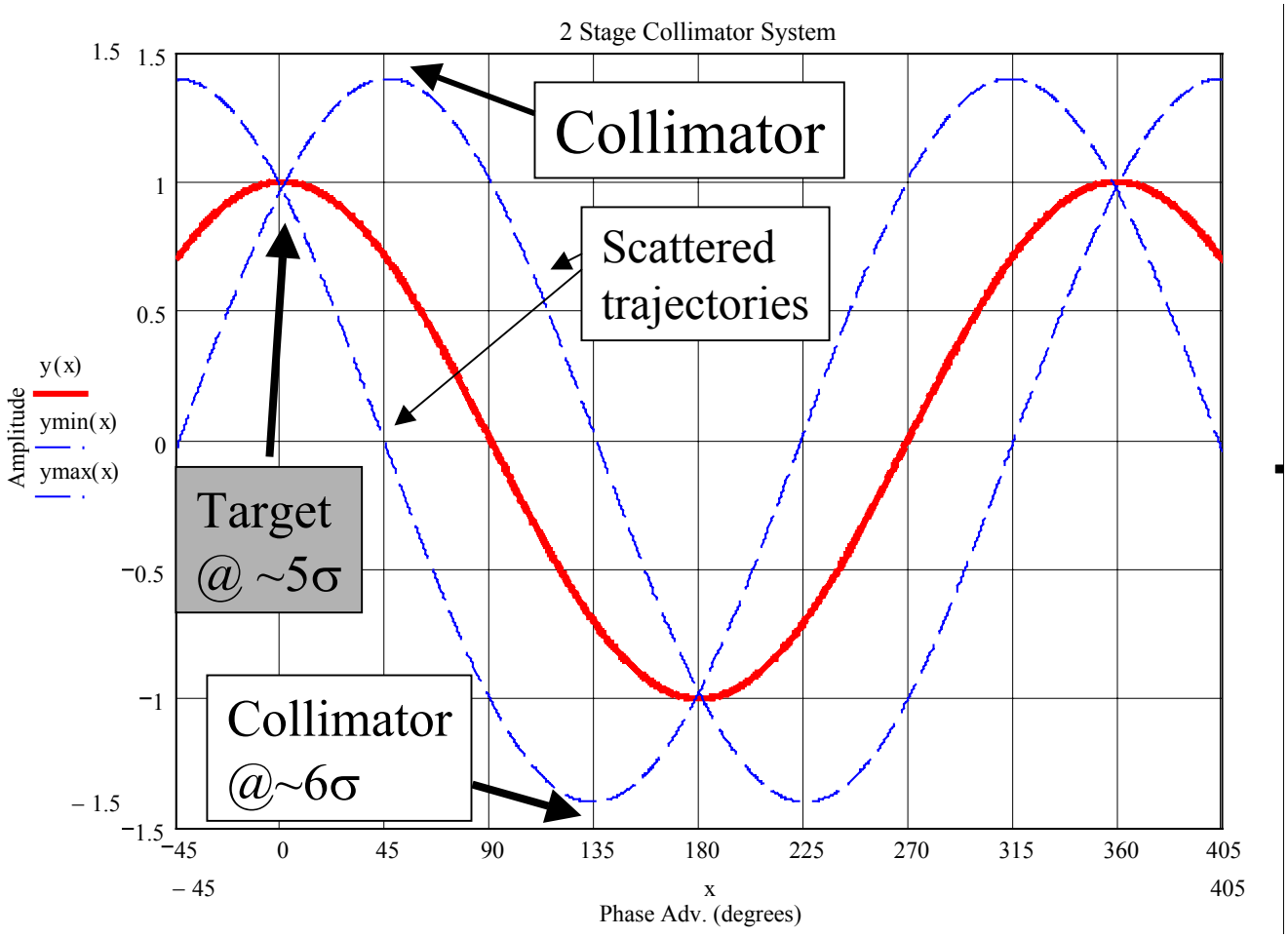
New design for the collimator system came from:

Tevatron Run-II Beam Collimation System

A.I Drozhdin and N.V. Mokhov

This paper along with the experience from Run-I was the basis for designing the controls and sequence of motion for the Tevatron collimator system.

2 Stage Collimator System

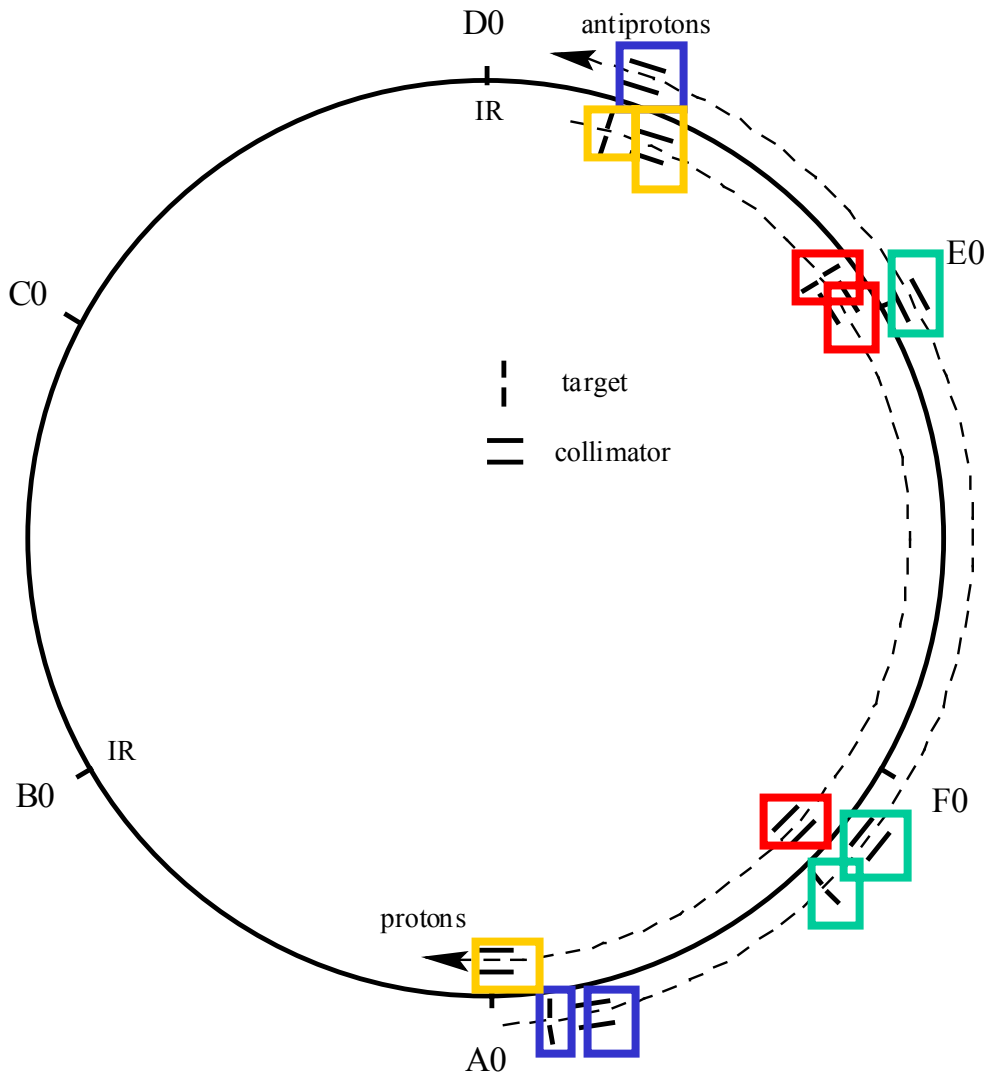


Tevatron Collimator Layout

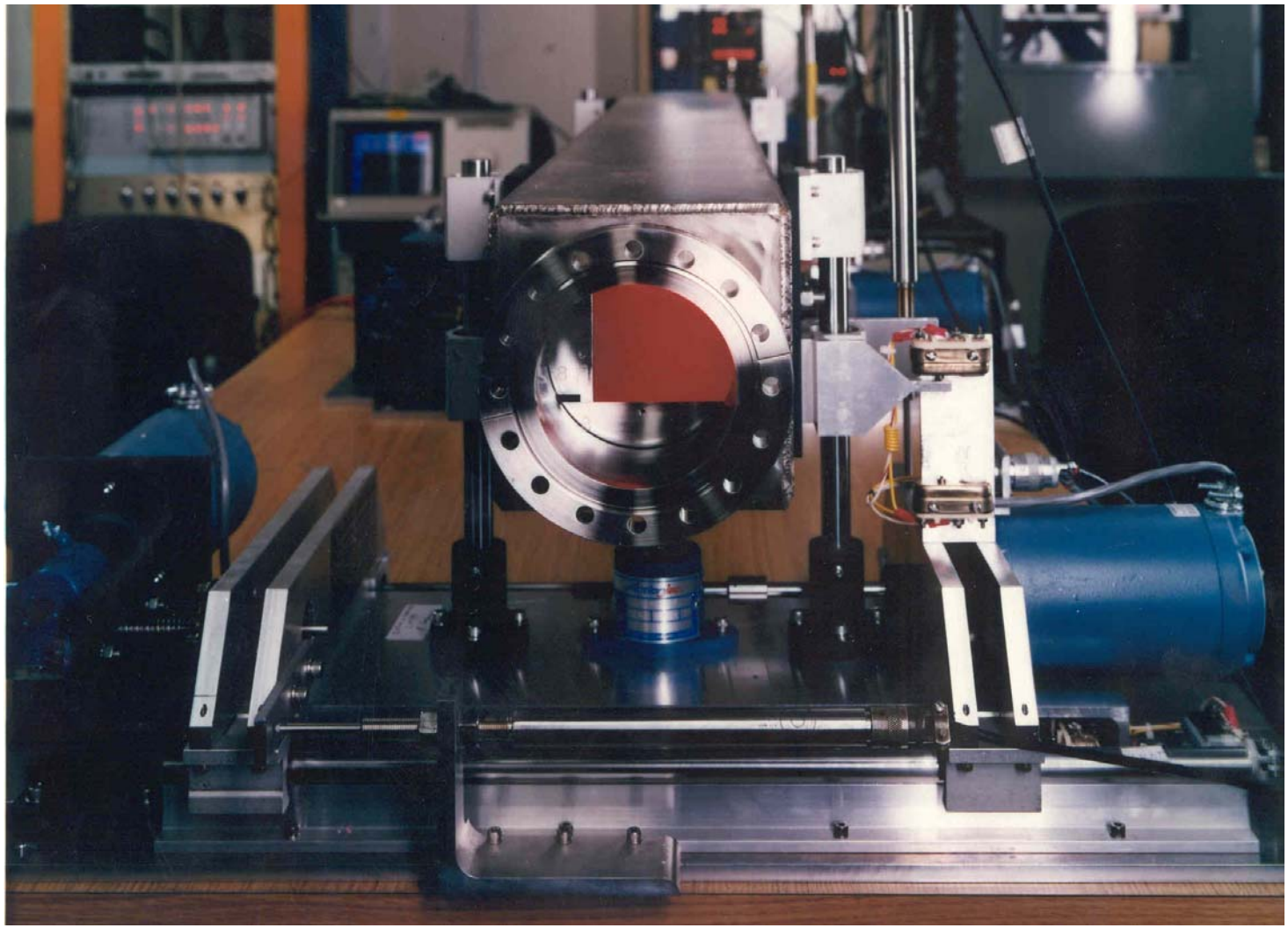
12 collimators total
4 Targets
8 Secondary collimators

Arranged in 4 sets
2 proton sets
2 pbar sets

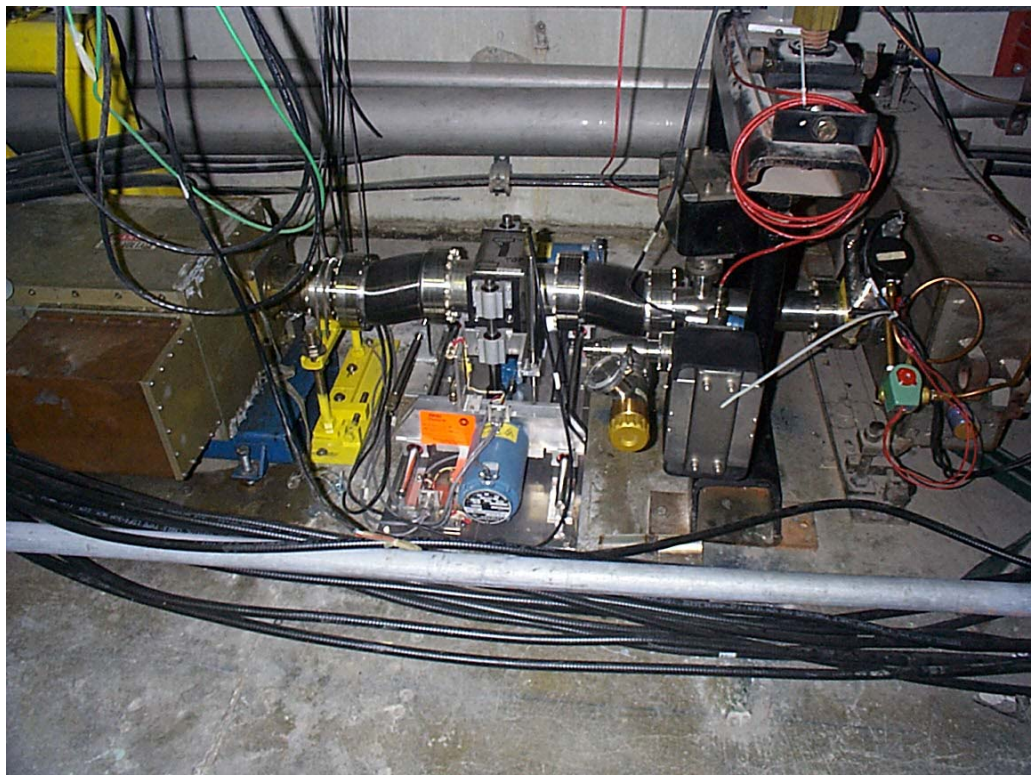
Proton Set 1
D49 Tar, E03 & F172 2nd
Proton Set 2
D171Tar, D173 & A0
Pbar Set 1
F49 Tar, F48 & D172
Pbar Set 2
F173 Tar, F171 & E02



Collider II 1.5m Collimator

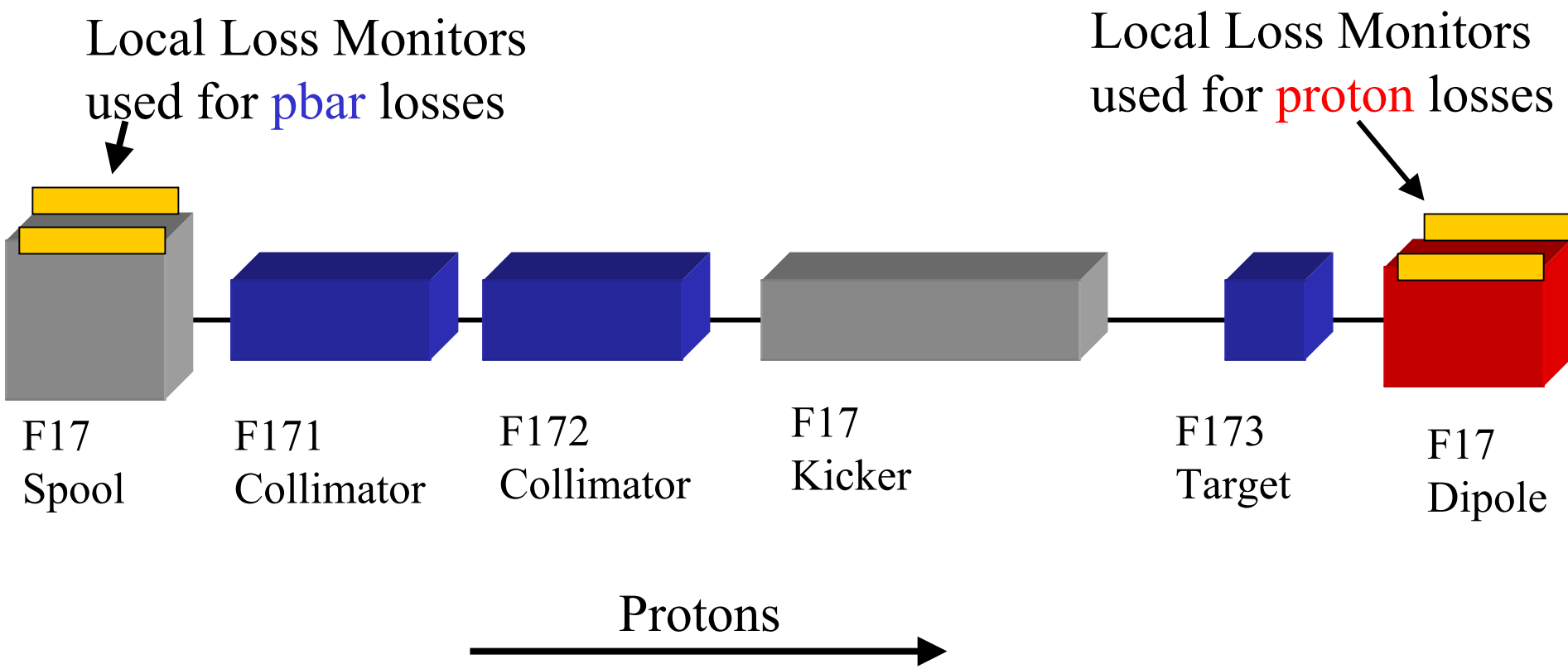


Collider II Target with 5mm Tungsten wing.



Collider II 1.5m E0 Secondary Collimators.

Tunnel Layout of Collimator Local Loss Monitors



Collimator Controls Hardware

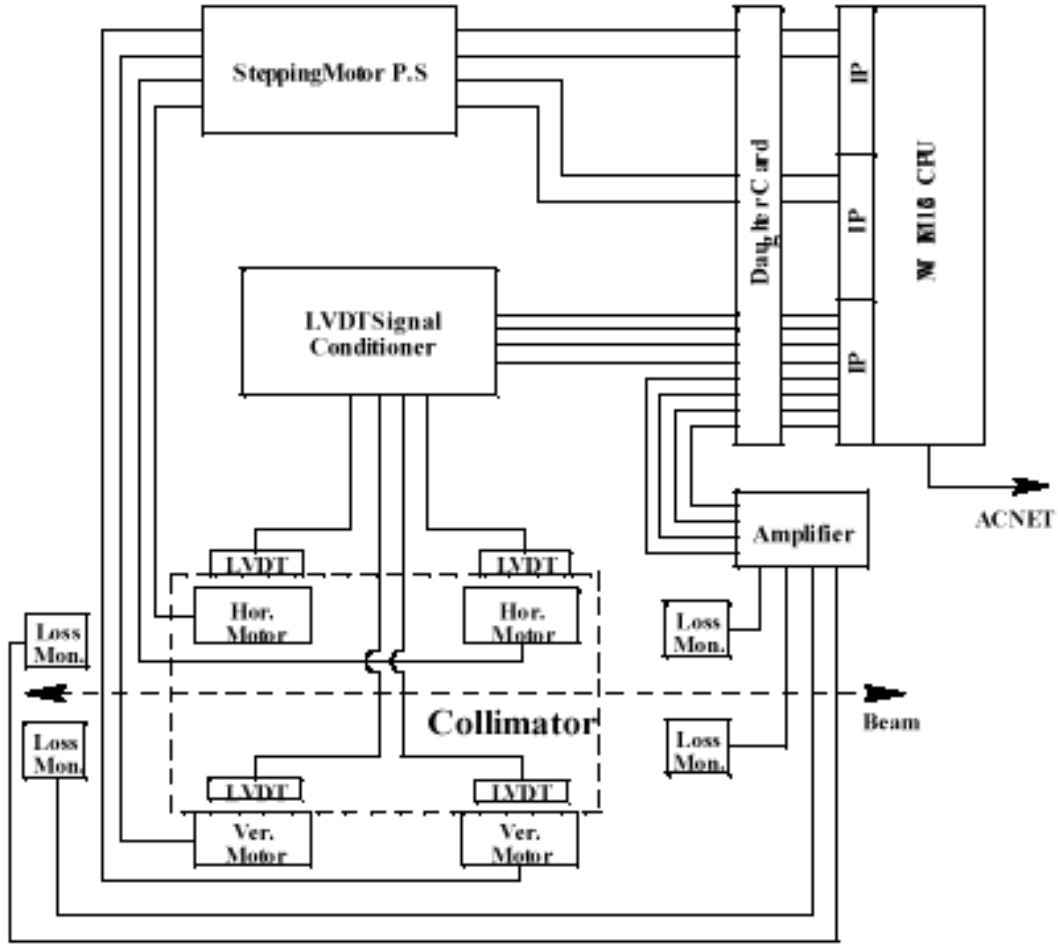
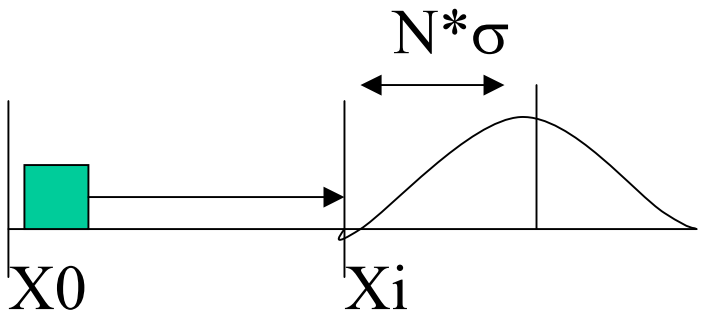


Figure 6.64. Block diagram of collimator control system

Overview of New Software



Front End	OAC	Application
Fast Processing :	Global Orchestration:	Configure/view, Initiate Process:
Loss Monitor & Intensity Feedback.	Employs states and collimator moving map.	Can use sequencer initiate scraping.

C10 - Controlling one Collimator

The left side portrays the details of the movement for D49H1 target for Begin Halo Removal.

Tevatron Shot Setup Process

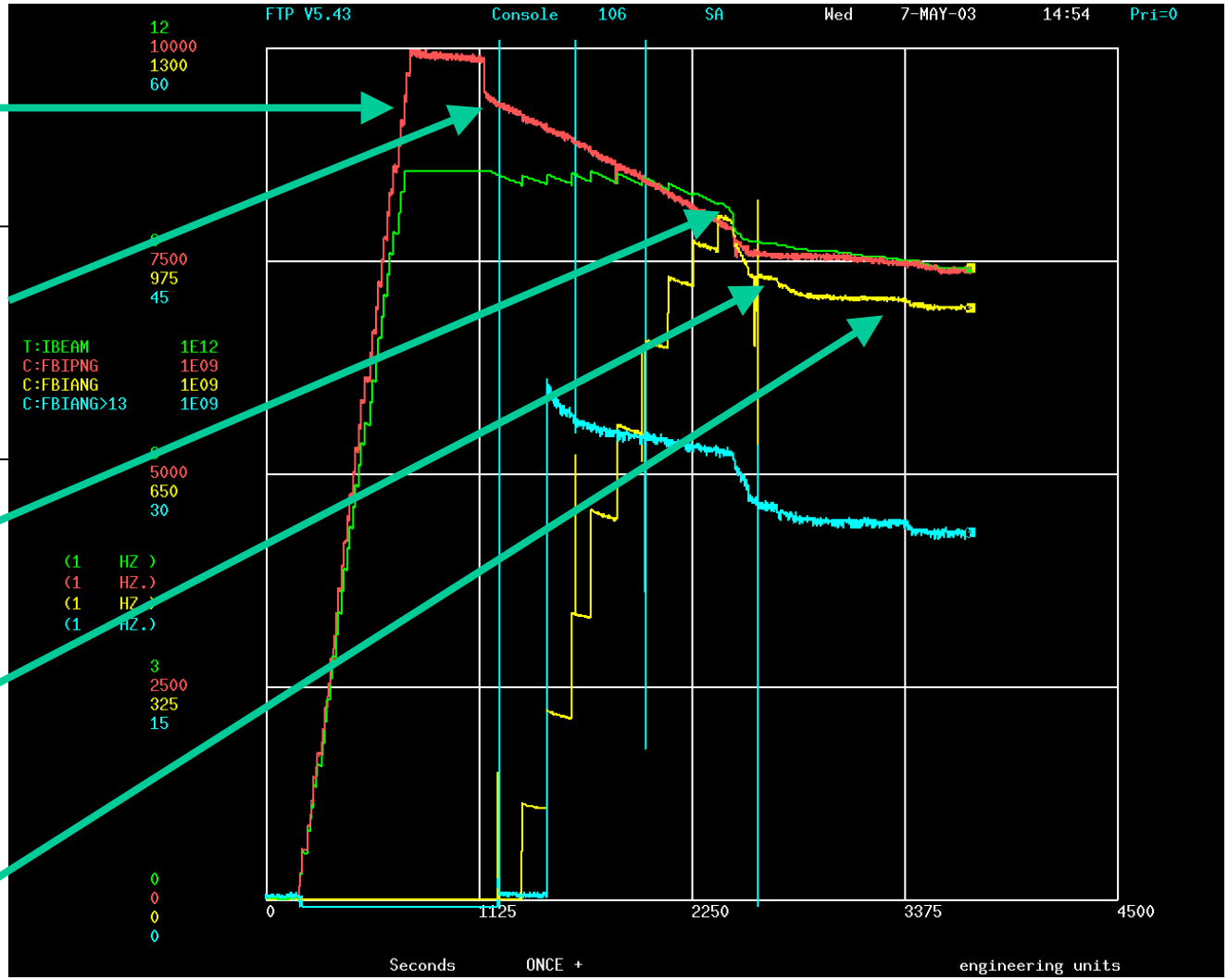
Inject 36 final protons

Open Helix & Inject 9 Trans of 4 Pbar bunches

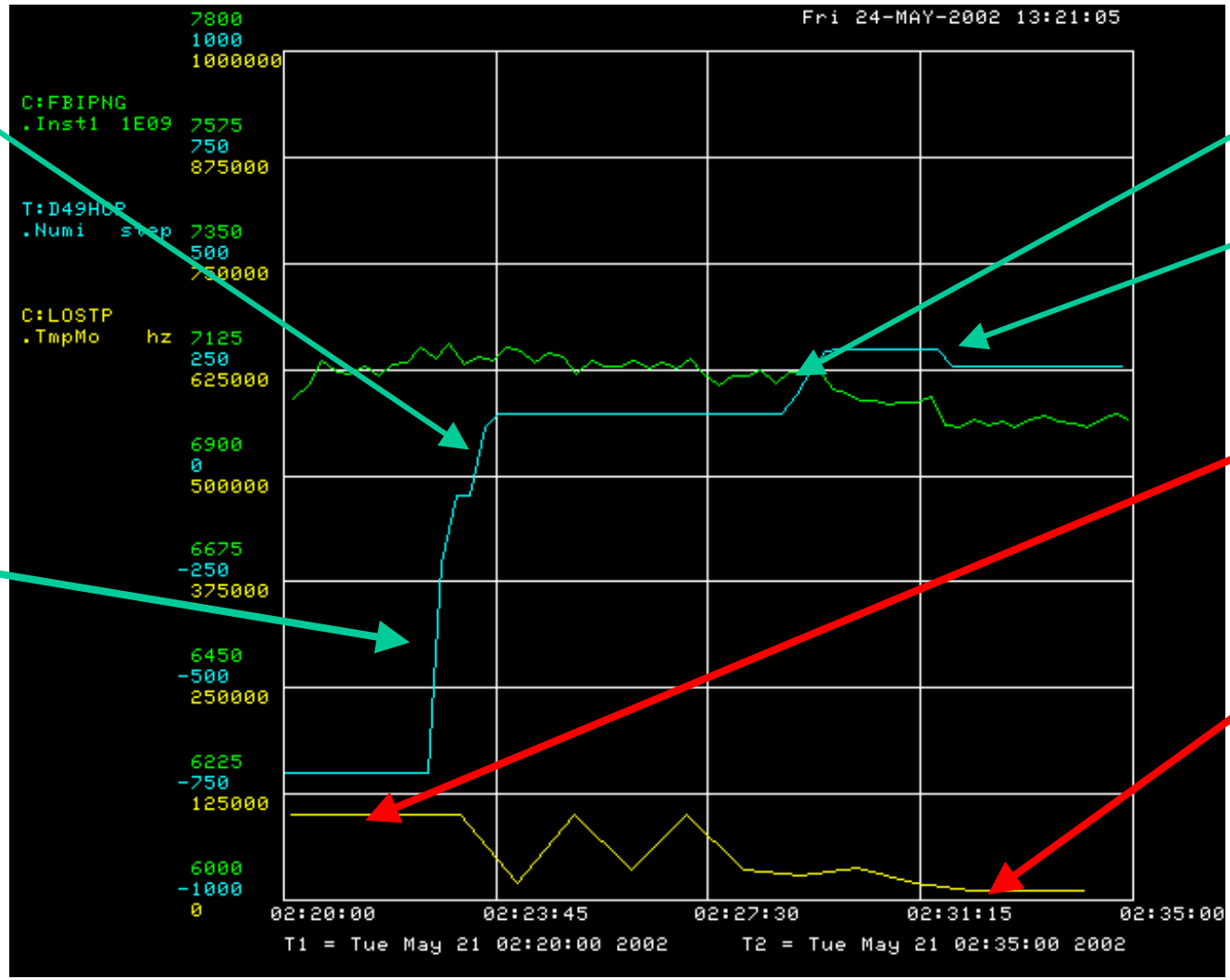
Accelerate

Goto Lowbeta

Remove Halo



Example of D49 movement during Halo Removal Process



Find the edge of the beam

Fine Scrape process: Scrapes .4% of proton beam

Retracted

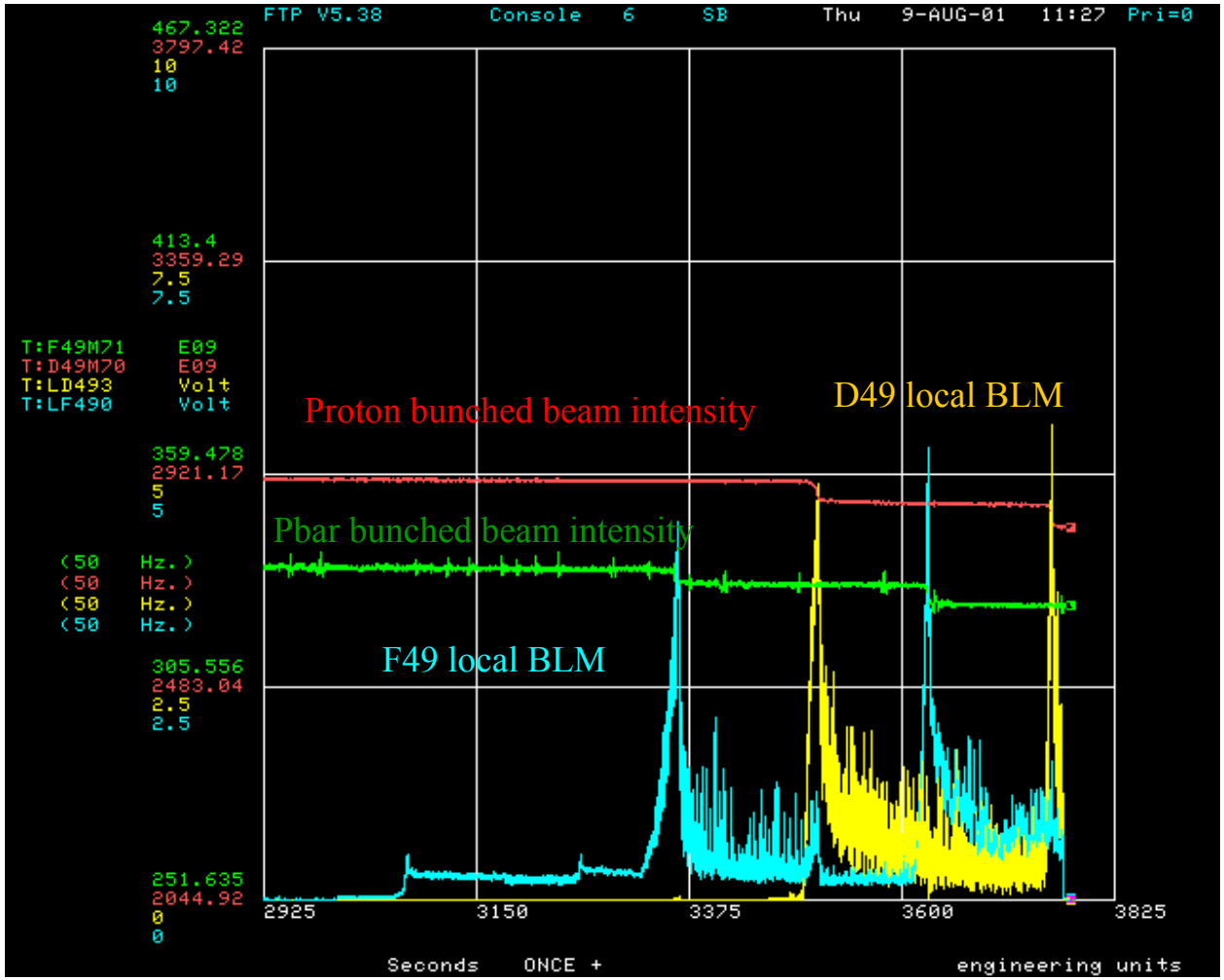
~ 40mils or 1mm

Before Halo removal CDF proton loss

Initial Move No feedback

After Halo Removal CDF proton loss

Proton & Pbar Targets moving during Halo Removal



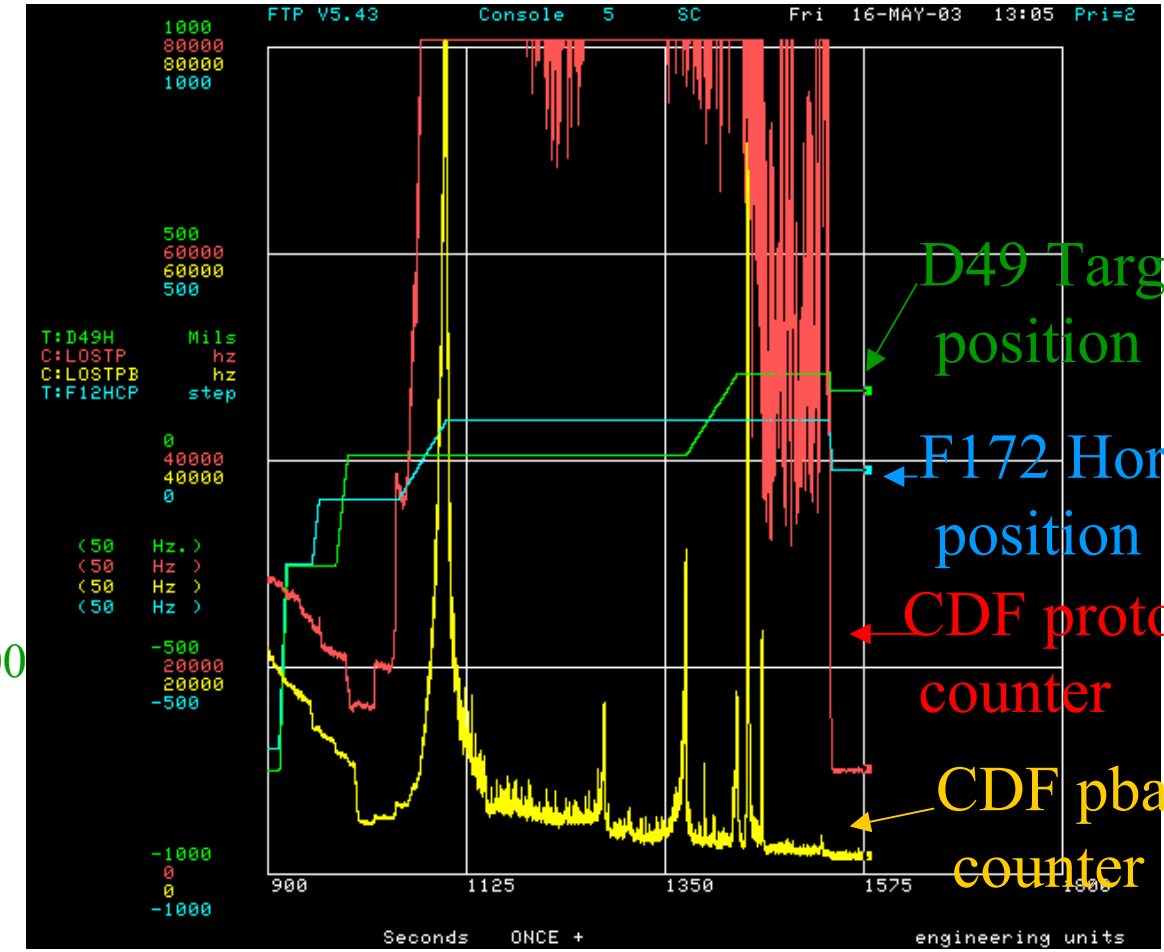
Merit of Halo Removal Efficiency

CDF proton halo loss
reduced by factor of 9

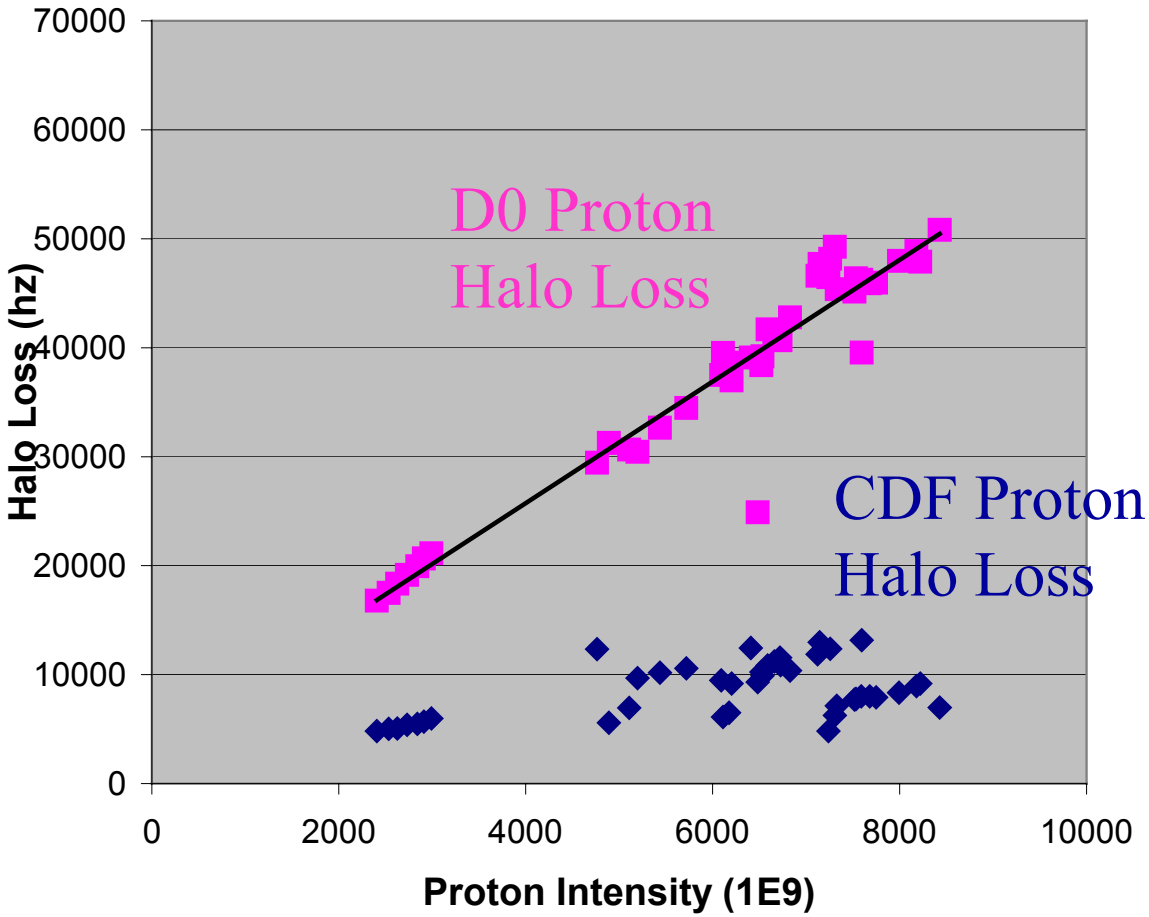
CDF pbar halo loss
reduced by a factor of 28

D0 proton halo loss
reduced by a factor of 1

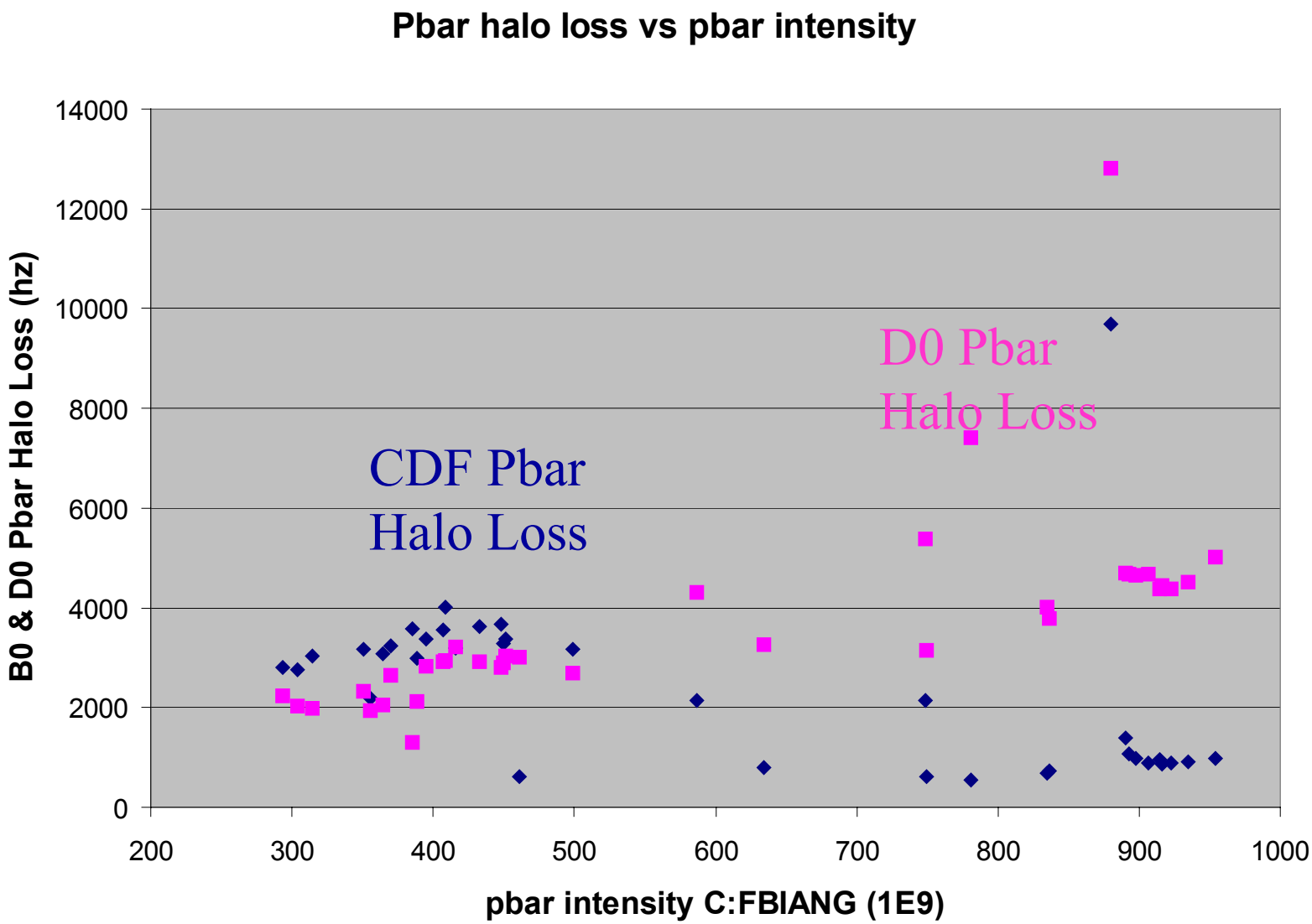
D0 pbar halo loss
reduced by a factor of 100



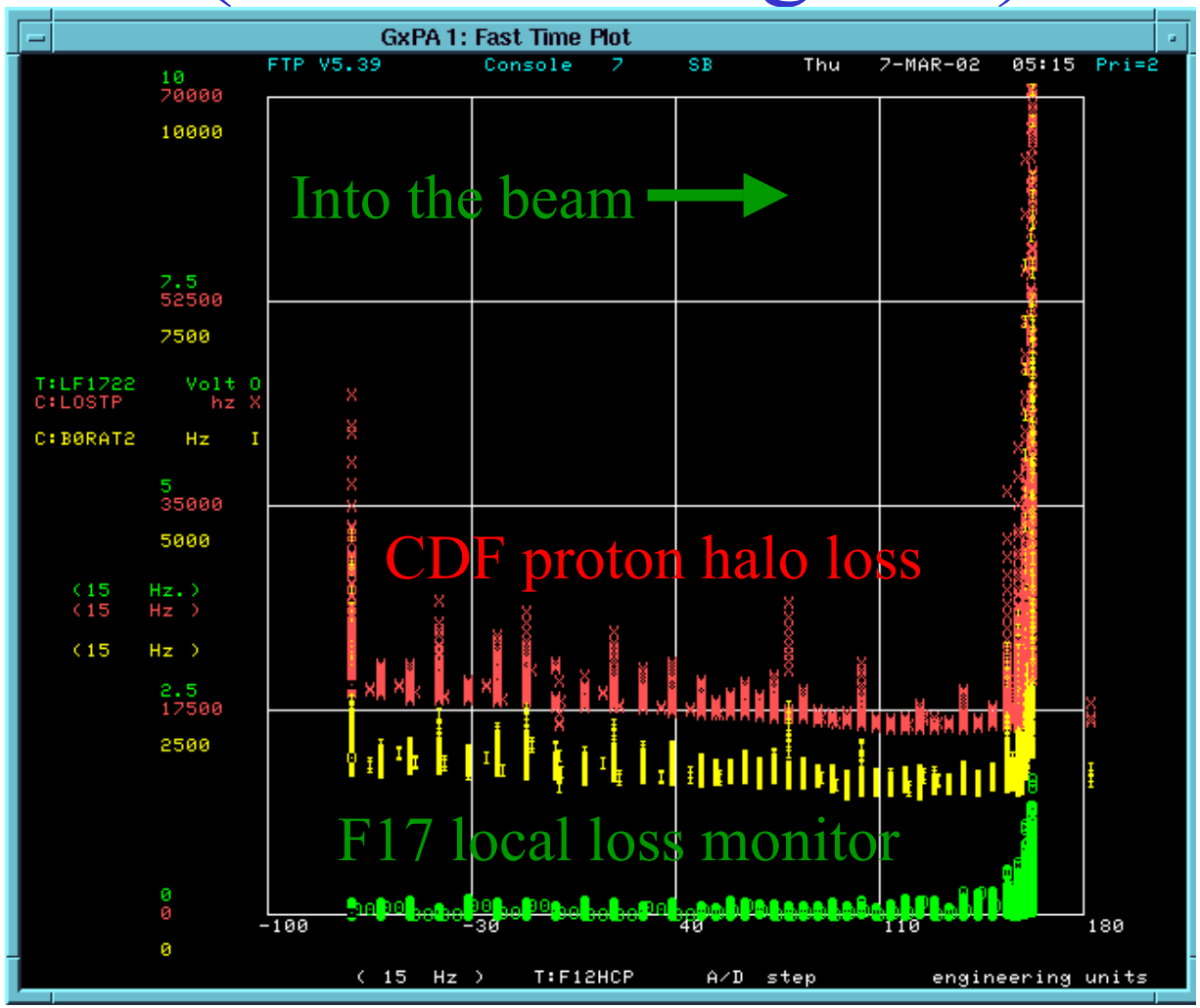
CDF & D0 Proton Halo Loss vs. Proton Intensity



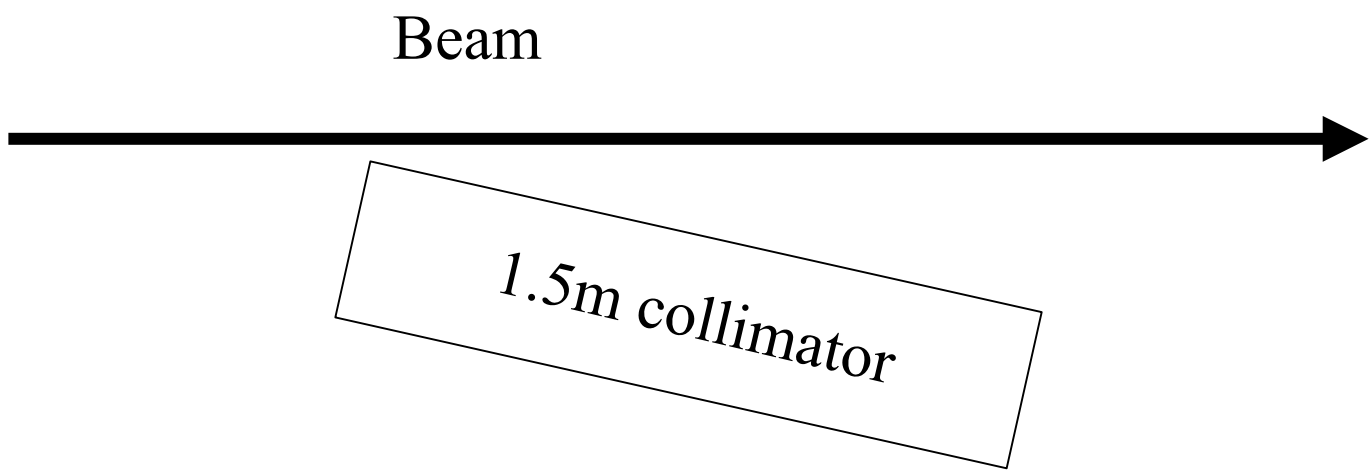
CDF & D0 Pbar Halo Loss vs. Pbar Intensity



F172 Horizontal Retraction Scan (with D49 target in)



Halo losses and collimator angle

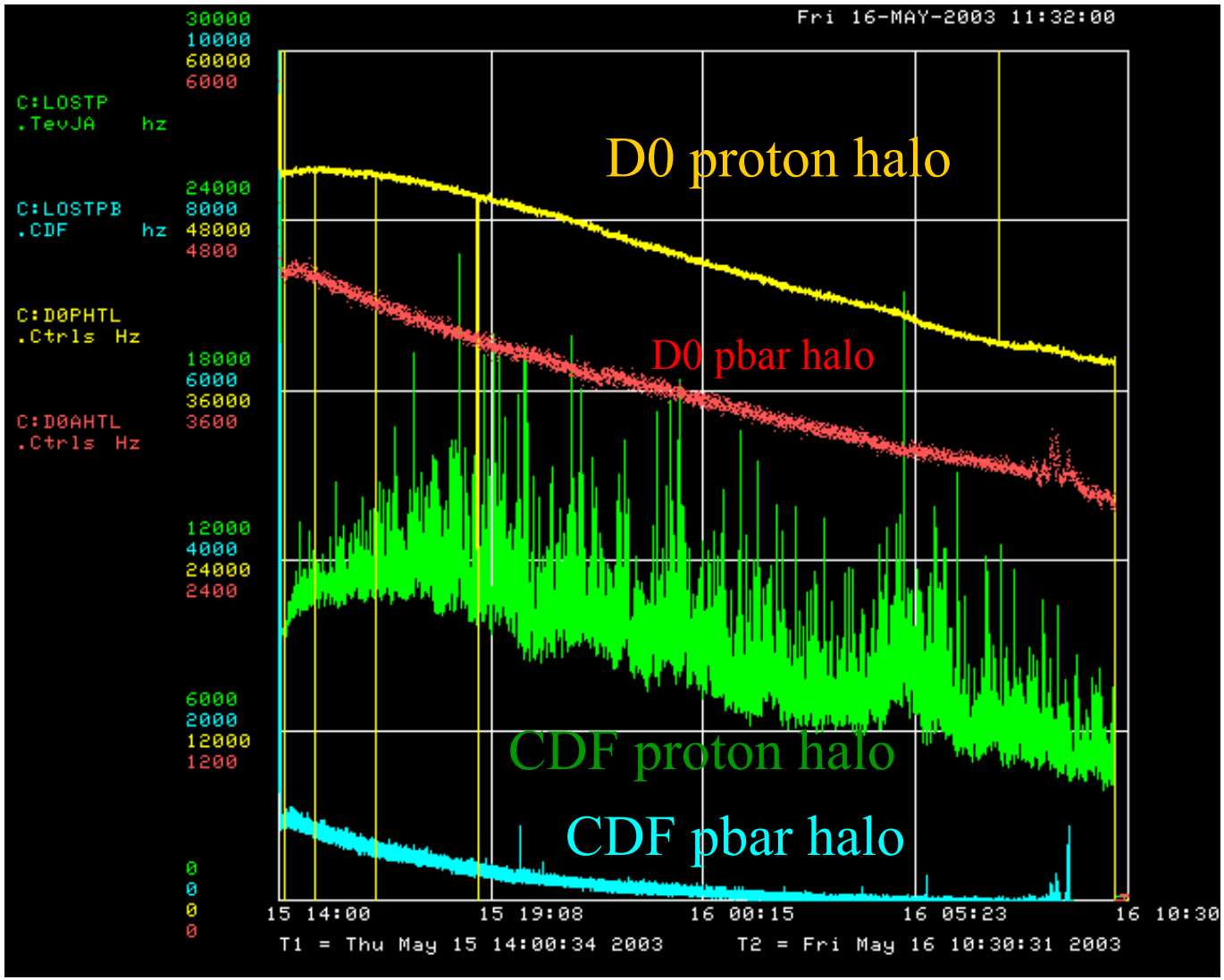


Good if < 10 mils difference from upstream to downstream.

Live with >10 and <30 mils difference from upstream to downstream.

Bad if > 30 mils difference from upstream to downstream.

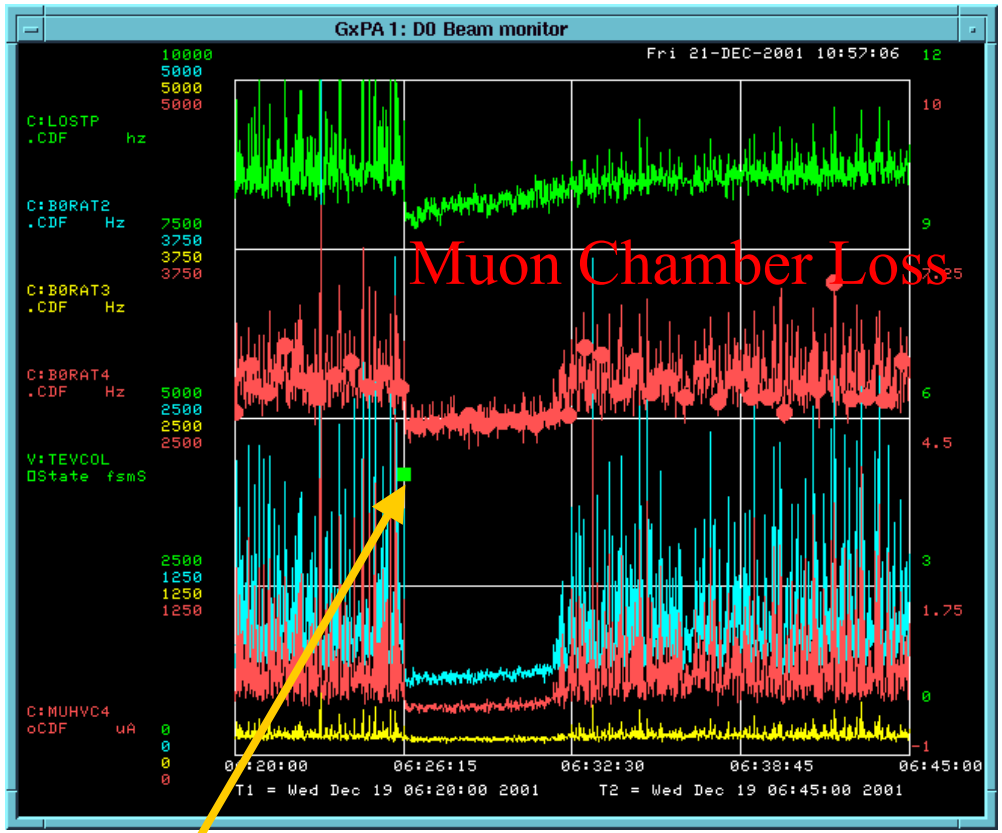
Typical halo losses during store 2549

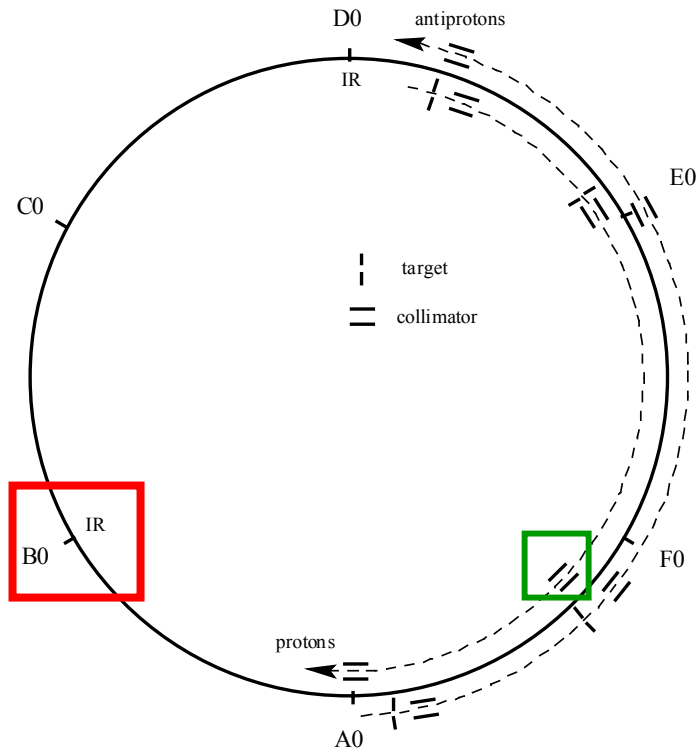


Collider Run II History of Experiences

Date	Events
June 2001	Used Automatic Halo removal system for first time
Aug 2001	•CDF experiencing power supply failure to crates on. •CDF sees "spikes" on proton halo losses and muon chambers.
Dec – Jan 2001	•Tevatron quenches on abort due to DC beam. •"Spikes" on CDF proton halo loss persist.
Jan-June 2002	Experience proton halo loss growth during stores due to poor F11 vacuum.
Feb 2003	•CDF added shielding at proton end of detector. •Tevatron removed C0 Lambertson- known aperture limit.
March 2003	Rash of A0 abort kicker prefires lead to addition of A48 collimator.

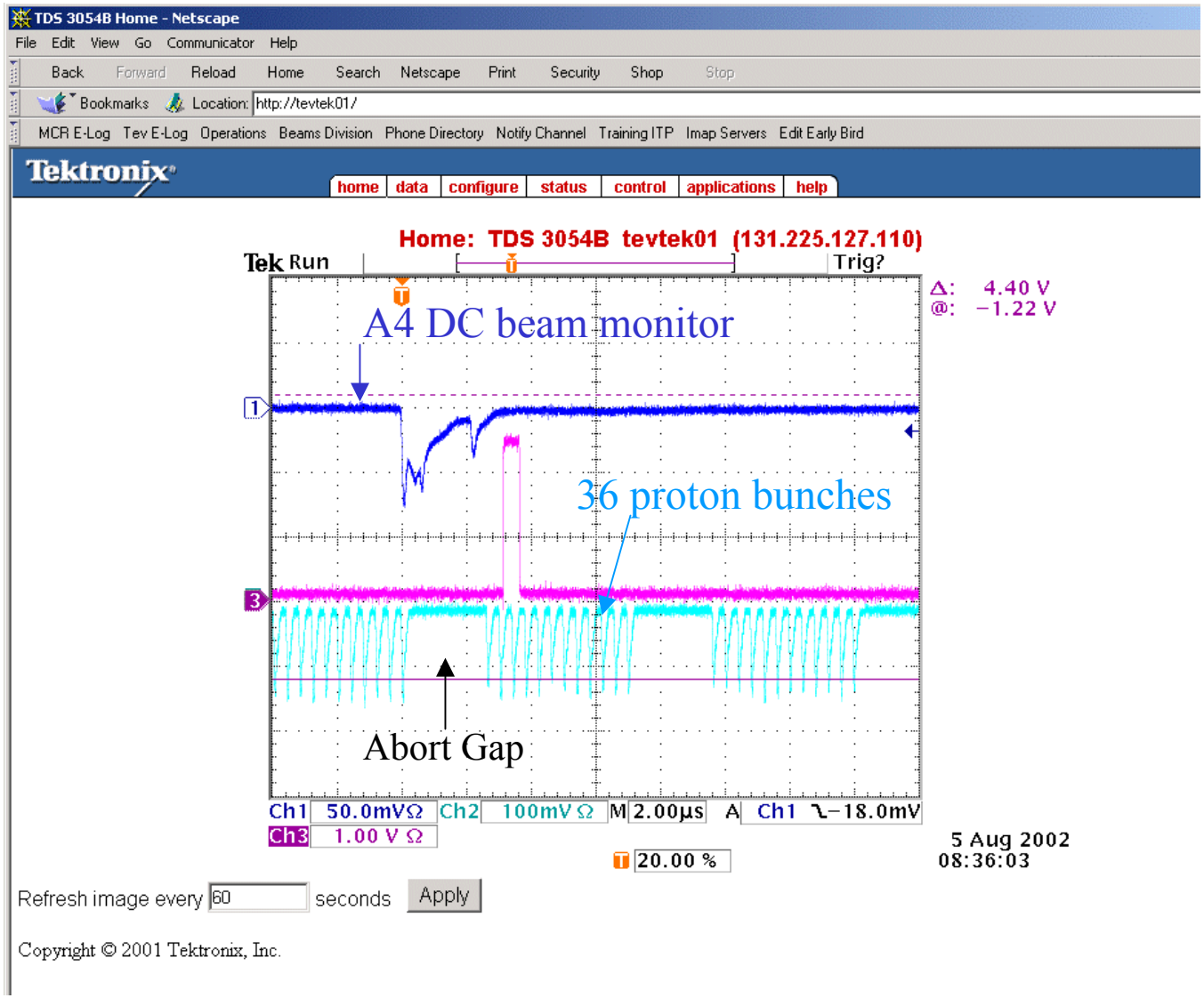
Retracting F172H effects losses in Muon chambers at CDF



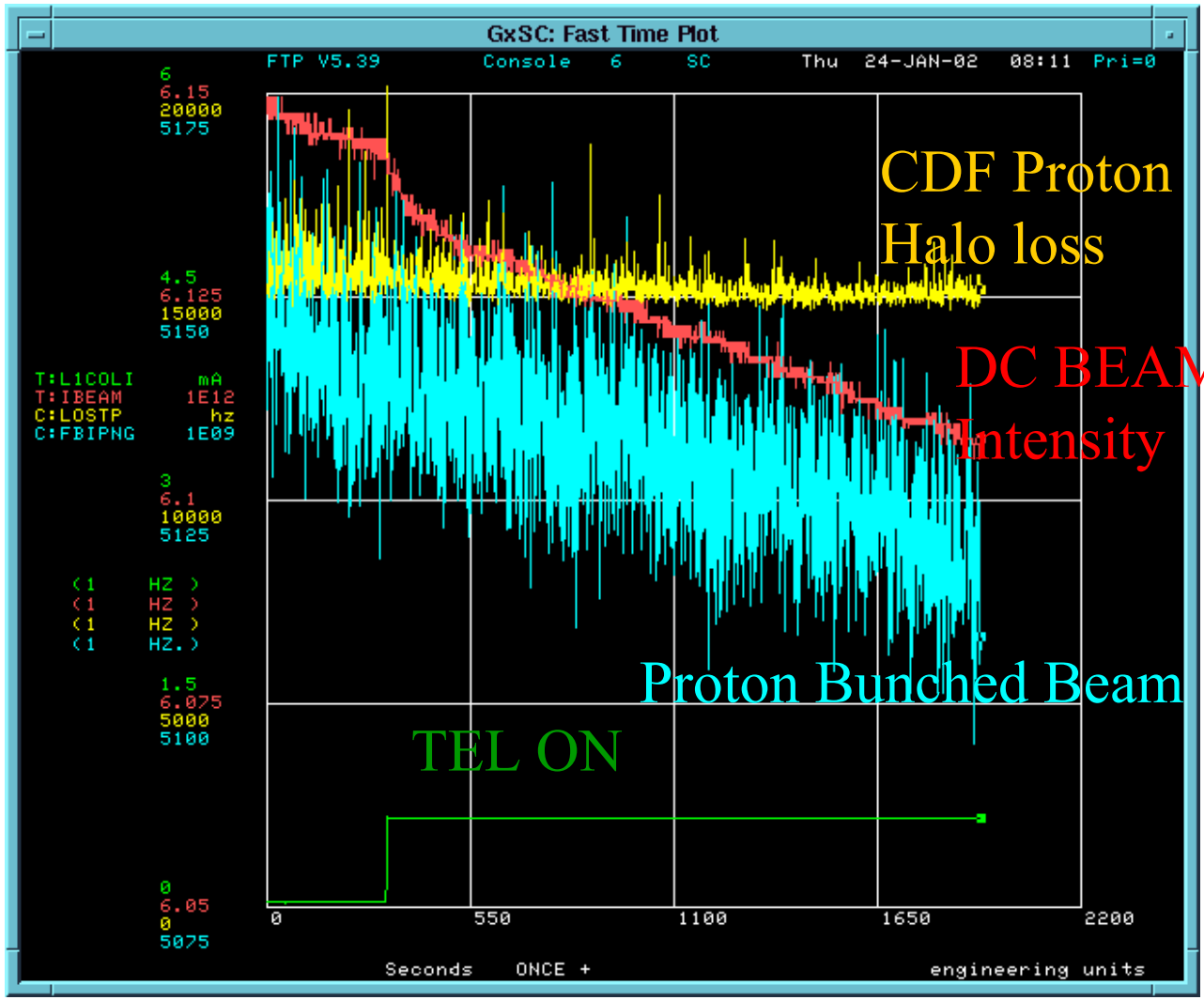


Retreact F172 collimator

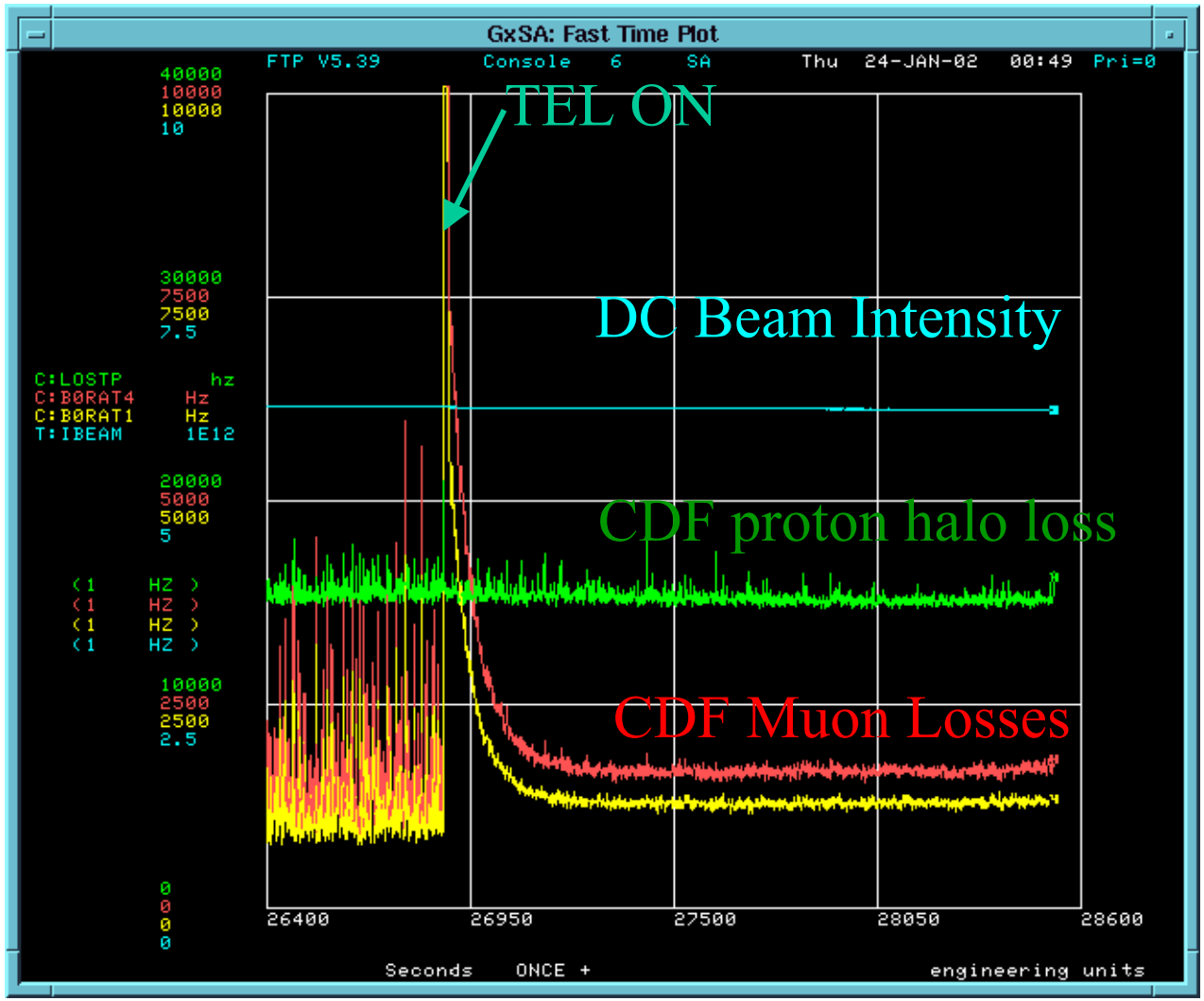
DC Beam at Collisions



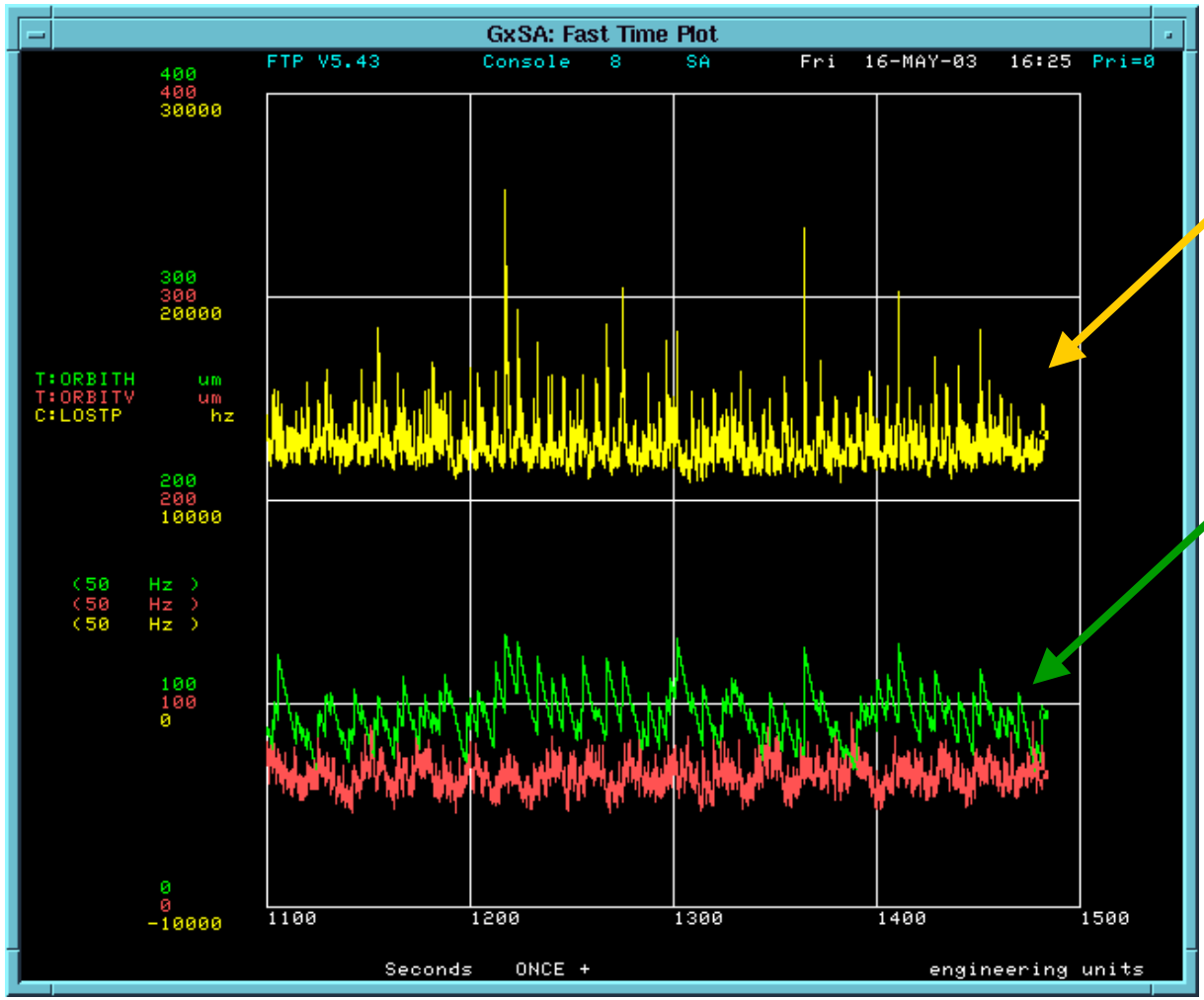
TEL getting rid of DC beam



Effects of reducing spikes on proton halo losses with TEL



CDF Proton Halo loss "spikes" correlated to horizontal orbit motion

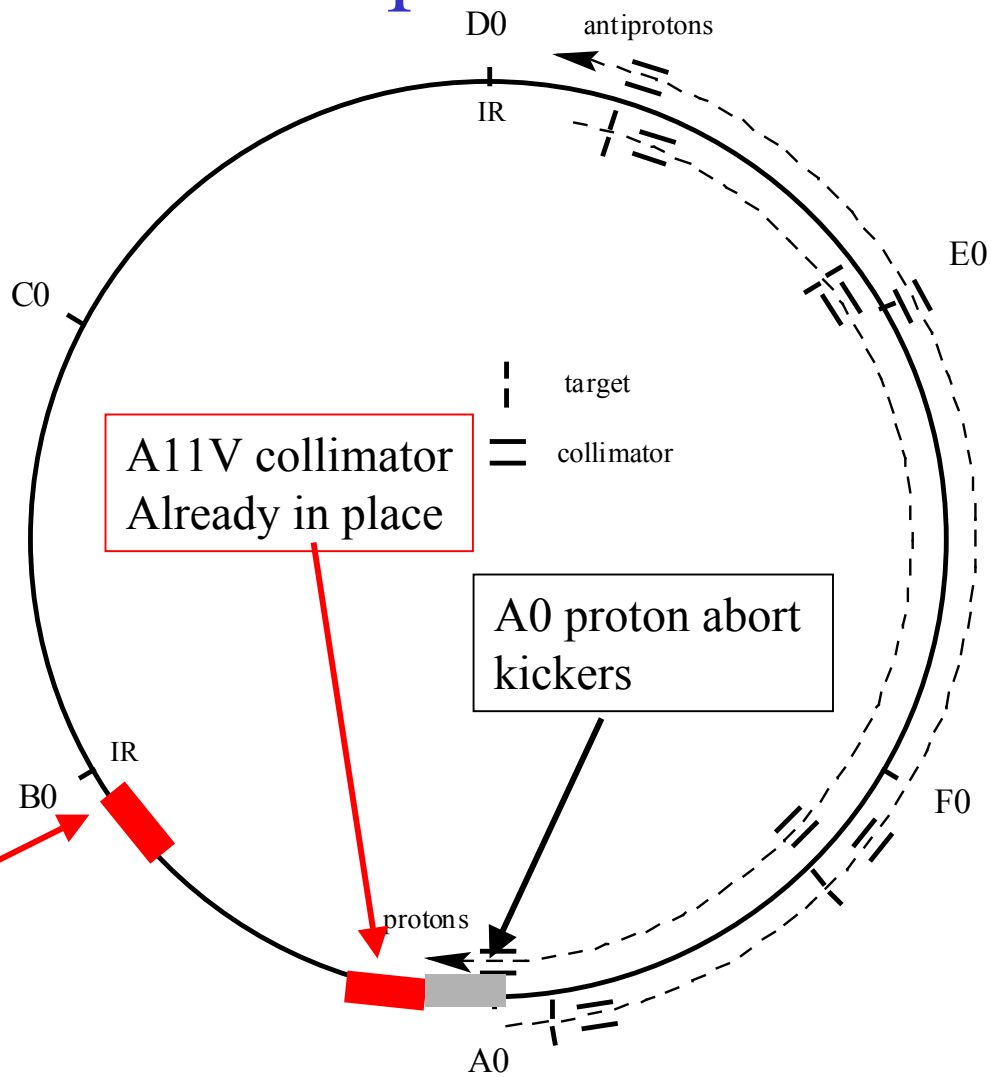


CDF proton halo Loss counter

Out of single BPM Processed to provide Orbit motion. Hor and Ver

Addition of A48 Collimator to Protect against A0 abort kicker prefires

	Date	# Prefires
Run I	4/1994 - 11/1995	6
Run II	3/2001- present	7



Add .5 m
Collimator
at A48 to shield
against prefires

In Closing:

- The design and implementation of the collider II halo removal system has worked well as far as reliability, speed , ease of use and status mechanics of conducting halo removal.

- The efficiency of reducing halo loss seems to be reasonable except for proton losses at D0 which requires more understanding.

- Only 1 proton and pbar collimator sets are used for halo removal. The other sets do not have much effect.

- The collimators require "aligning" once in awhile to reduce losses from beam not parallel to collimator.

- The TEL is an operational must in order to maintain spikes in CDF proton halo losses and remove DC beam accumulated in the abort gaps through out the length of a store.

- Attempts are being made to understand and improve overall vacuum.

- An additional .5 m collimator will be installed at A48 in order to reduce